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SACCHARINE SORGHUMS FOR FORAGE.

BY

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., January 11, 1906.

SIR: I have the honor to transmit herewith a paper entitled "Saccharine Sorghums for Forage," prepared by Mr. Carleton R. Ball, of this Bureau. This bulletin supersedes Farmers' Bulletin No. 50, and I recommend that it be published as a new bulletin.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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SACCHARINE SORGHUMS FOR FORAGE.

ORIGIN.

There can be no doubt that sorghum originated in a tropical or semi-tropical region. It is supposed to have been derived from equatorial Africa, where it is now represented by very numerous and widely different varieties. At the present day it is more or less extensively cultivated in some of its various forms in all the tropical regions and all the warm temperate regions of the earth. In north China, Manchuria, India, and many countries of Africa it forms an important part of the food supply for the human race as well as for domestic animals.

CLASSIFICATION OF SORGHUMS.

There is an extremely large number of forms and varieties of sorghum. They hybridize or cross with the greatest readiness, and the number of forms, as well as the tendency to vary, seems to be constantly increasing. Many of the more distinct varieties have at one time or another been regarded as distinct species. They have been separated, however, on comparatively unimportant characters, such as the shape or position of the head, or panicle, and the color of the glumes (or chaff) which inclose the seeds. When the similarity of actual structure is considered, it is evident that there is but a single species represented in all the various forms.

All the forms cultivated in this country may be readily separated into three main divisions: (1) Broom corns; (2) saccharine, or sweet sorghums; and (3) nonsaccharine sorghums.

This bulletin deals only with the second division, but for purposes of comparison brief descriptions of the broom corns and the nonsaccharine sorghums are given.

BROOM CORNS.

The broom corns are characterized by straight stems, which do not branch from the upper nodes, or joints, and by very long, straight, loose, and open seed heads, usually light-colored, which are used in the making of brooms and brushes. The stalk is dry and pithy, lacking the sweet juice, though otherwise broom corn is most closely related to the saccharine sorghums.

SACCHARINE SORGHUMS.

The saccharine sorghums are popularly recognized by reason of their sweet sap or juice, from which sirup and sugar are made. In general, they are of tall and leafy growth, branching only sparingly at the upper nodes, or joints, and not stooling much at the base under ordinary cultivation. The seed head, or panicle, varies from the close, compact "club" head of the Sumac sorghum through the rather more open heads of Orange, Gooseneck, and other varieties to the loose and often widely spreading head of the Amber variety, with the lower branches often drooping as the seed ripens. The seeds are red in the Sumac and reddish-yellow in the Orange and Amber sorghums. They usually protrude somewhat from between the glumes, or chaff, which in these varieties vary from deep red to black in color.

NONSACCHARINE SORGHUMS.

The nonsaccharine sorghums have usually a stouter stalk, with considerable juice, which is, however, less abundant and less saccharine than in the sweet sorghums. On the shape and position of the head and the shape of the seed they may easily be separated into two groups, namely, the Kafir group and the Dhoura group.

The Kafir group includes Red Kafir, White Kafir, Black-hulled White Kafir, and White Milo, the last of which is often called White Milo Maize or Large African Millet, and is also known by many other names. These are all characterized by erect, rather long and compact, cylindrical heads full of obovate seeds (egg-shaped with the large end outermost), which are either white or red, as indicated by the name. White Milo may be separated from Black-hulled White Kafir by its much taller growth, longer internodes (space between joints of the stem), and larger and lighter-colored, yellowish leaves.

The Dhoura group includes Jerusalem Corn, Brown Dhoura, and Yellow Milo. These are distinguished by thick, compact, ovate (egg-shaped) or "club" heads, and quite large and considerably flattened seeds, varying in color from white in Jerusalem Corn to reddish-yellow in Yellow Milo and reddish-brown in Brown Dhoura. A large percentage of the heads in all these varieties are pendent on recurved stems or "goosenecks." Egyptian Corn, Branching Dhoura, Rural Branching Sorghum, and Dhoura Corn are some of the names given to members of this group.

INTRODUCTION INTO THE UNITED STATES.

Although broom corn and certain nonsaccharine sorghums were brought into this country in early colonial times, it is only a half century since the first varieties of the saccharine group were introduced. In the year 1851 the French consul at Shanghai, China, secured

some seed of a saccharine sorghum from the island of Tsung-ming, at the mouth of the Yangtze River. When planted in France but a single seed grew and developed into a mature plant. The eight hundred or more seeds from its head were sold for 1 franc (nearly 20 cents) each. From this stock of seed the culture was begun in France. In 1853 a small importation of French seed is said to have reached Long Island, and in 1854 it was distributed on a small scale. In 1855 and 1856 the distribution of seed was made on an increasingly large scale, the first distribution by the United States Government occurring in the latter year. Thus the cultivation of the sweet or saccharine varieties in America began with a single variety of Chinese origin. It was commonly called Sorgho, Chinese Sorgho, or Chinese Sugar Cane at first, and later was known as Old or Regular Sorgho to distinguish it from the African varieties.

Early in 1851 Mr. Leonard Wray, an English merchant, arrived in Natal, South Africa, and soon became interested in the numerous varieties of saccharine sorghums grown there by the Zulu-Kafirs for the grain and sweet stalks. In 1854 he grew some sixteen of these varieties in Italy, Spain, France, England, and other parts of Europe. He published his descriptions of them in both English and French. These sixteen varieties were brought from Europe to this country in 1857 and grown in Georgia and South Carolina, and were soon distributed throughout the sorghum-growing region. These African varieties were all called by the general native name of Imphee, though in addition each variety had a native name.

About 1865 four other varieties were received from China. Later, about 1880, numerous varieties were again received, both from China and from Natal.

It must be remembered that all these importations of varieties and all the immense amount of attention which sorghum received from the Department of Agriculture and from American farmers were directed toward the production of sirup and sugar and not the production of forage. Many persons had early noticed the great relish with which the green or cured plants, the seeds, and even the crushed stalks were eaten by different classes of live stock. These observations were announced in the public press, in scientific journals, and in the reports of the Department of Agriculture; but the demand for a sugar plant was so great and the demand for a coarse forage plant so small that little attention was given for many years to the use of sorghum as forage.

AREA AND IMPORTANCE OF CROP.

It is impossible to give any accurate statistics of the acreage of sorghum now grown annually for forage in this country. In the census reports sorghum grown for forage is not considered separately,

but is included under "forage crops." The principal crops included under this title are corn, sorghum, and Kafir corn. Corn and Kafir corn grown for grain are excluded, only the acreage grown primarily for green or cured fodder being listed. According to the census of 1900, the area devoted to such forage in 1899, including Alaska and Hawaii, was 3,107,241 acres, with a total yield of 8,139,124 tons, an average of 2.6 tons per acre.

What proportion of this area was devoted to saccharine sorghums and what part of the tonnage they furnished can not be ascertained from the census figures. It is possible, however, to throw some light on this question from another source. Kansas alone is credited with 1,041,447 acres and 2,728,321 tons of the combined crop. This is almost exactly one-third of the total. The very comprehensive statistics published in recent years by the Kansas State board of agriculture make it possible to determine the acreage of sorghum grown for forage in that State in 1899. It was approximately 448,000 acres. This shows that about three-sevenths of the area which the census figures show to have been devoted to these coarse forage crops in Kansas in the year 1899 was planted in saccharine sorghum. It is true that a portion of this was grown for seed, but sorghum is seldom grown for seed alone, the intention being to use the stalks for forage where the seed heads are allowed to ripen. The proportion of sorghum to these other forage crops as shown by the statistics for Kansas is probably not too high for the rest of the country. This would give approximately 1¾ million acres of saccharine sorghum grown for forage in the United States in the year 1899, which is equal to about one-seventieth of the area devoted to corn in the same year.

There can be no doubt that the area devoted to sorghum grown for forage purposes is steadily increasing. Statistics for Kansas may be again examined. In 1893 there were grown in that State 132,205 acres for forage and 40,688 acres for sirup. In 1899, the year in which the census was taken, the area in saccharine sorghum grown for forage had increased to 448,798 acres, while that grown for sirup was only 20,343 acres. In 1903 the acreage of saccharine sorghum grown for forage had increased to 605,321, diminishing, however, to 571,033 in 1904. This increase in the sorghum acreage was made in spite of a very heavy increase in the acreage devoted to Kafir corn. Kafir corn for forage and grain was grown in Kansas in 1893 to the extent of 46,911 acres, which had increased in 1899 to 618,895 acres, and to 748,176 acres in 1902. In 1903 and 1904 the acreage of Kafir corn was largely decreased, though still somewhat in excess of the sorghum acreage. It thus seems certain that the area devoted to this forage crop is steadily increasing throughout the country. The constantly increasing demand for information about sorghum and the numerous

communications concerning it in the agricultural press testify also to this fact.

Several factors have combined to increase the acreage of sorghum. The increasing demand for silage crops and the adaptability of sorghum to this use are important causes. The general use of the corn binder has made it possible to handle sorghum fodder easily and economically. The larger forage yield to the acre and the greater drought resistance of sorghum have helped also to increase its use more rapidly than that of corn for forage purposes. These last two factors have operated especially in the Southern States, where two to three and sometimes four cuttings may be obtained in a single year, and in the arid region, where corn suffers from drought and hot winds. In these regions it is regarded as the leading forage crop. Its culture has been extended throughout almost the entire country, the only exceptions being certain portions of the extreme Northern States, where varieties that can successfully compete with corn have not yet become acclimated, and in the higher altitudes of the western mountain region.

While the area annually sown for forage has increased very materially during the last twenty years, there has been a decrease in the quantity grown for the manufacture of sirup and sugar. According to the census figures, 415,691 acres were grown for sirup in 1889. This area had decreased to only 293,152 acres in 1899. The yield in that year was 1,910,046 tons of cane, which is slightly over 6½ tons to the acre. These figures are of course for the green weight, and probably the weight after the cane had been stripped of its leaves and tops. The total farm value of the sirup and cane sold was $6,103,102. In Kansas the number of acres devoted to sorghum grown for sirup making diminished from 40,000 in 1893 to 14,000 in 1904.

VARIETIES OF SACCHARINE SORGHUMS.

The original importation of sorghum comprised a single variety of Chinese origin and about fifteen varieties from Natal, South Africa. Some years later others were secured from each of these two sources and a few were brought in from India. In 1882 there were said to be seventy-eight varieties growing on the grounds of the United States Department of Agriculture, most of them having been direct importations. A large number of forms—sports, and so-called hybrids—have been named as distinct varieties in different parts of the United States. From the beginning of the sorghum industry in this country up to the present time probably no less than two hundred so-called varieties have been named and cultivated. Most of them never attained any prominence outside of the locality where they originated. New names are frequently appearing at the present time. Although

so many varieties have existed, only a very few are in cultivation at present. Some of them have been developed for their saccharine content rather than for their forage value. The varieties now in cultivation may be separated into three or four groups, each consisting of a single well-marked variety or such a variety and a number of forms derived from it. Such groups are the Amber sorghums, the Orange sorghums, the Sumac sorghum, and the Gooseneck sorghum.

AMBER SORGHUM.

One of the oldest of the varieties now in use, Amber sorghum, is said to have been developed in Indiana from the original Chinese sorghums. It is an early variety and became very popular in the northern part of the United States because its earliness permitted it to be grown at points where other varieties failed to mature. It soon became known as Early Amber, and Minnesota-grown seed was put on the market under the name of Minnesota Early Amber—a strain which is still handled commercially. Recently seed has been offered also as Wisconsin Amber, as Improved Amber, and as Earliest Black. The three strains last named do not differ from ordinary Early Amber except, perhaps, in earliness. The Early Amber sorghum and its other forms still remain the earliest varieties known in this country, where they have been cultivated for nearly forty years. They require seventy to one hundred days to reach maturity, the time varying according to the latitude, season, and soil.

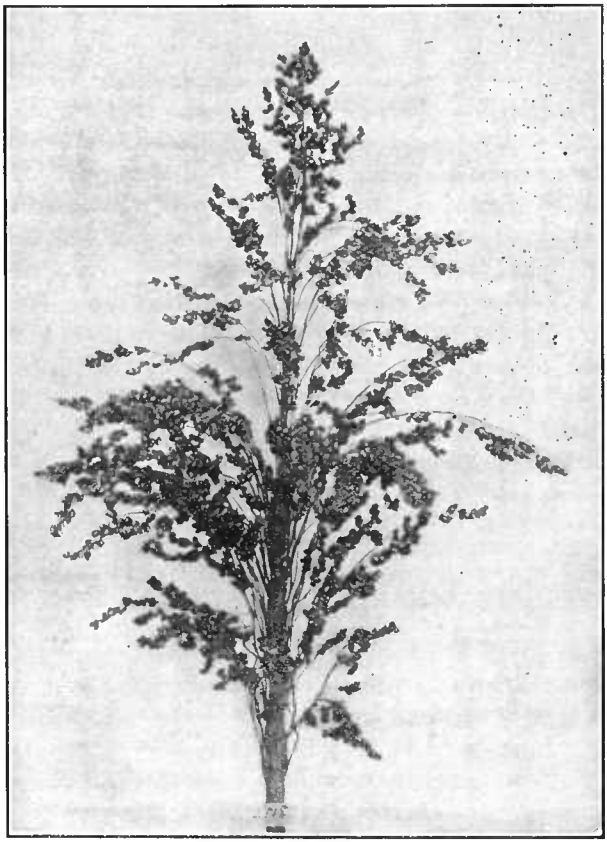

FIG. 1.—A head of Amber sorghum. (One fourth natural size.)

The Early Amber sorghum is characterized by rather slender stalks and comparatively narrow leaves. The seed heads, or panicles, are black in general color and vary considerably in shape and size. In general, they are rather loose and open and typically pyramidal or cone-shaped in outline, with the slender branches spreading and the lower ones drooping as the seed becomes ripe. The reddish-yellow seeds are nearly concealed by the shining black glumes, or chaff, so that the color of the mature panicle is a jet black.

FIG. 2.—A field of Amber sorghum.

The variety known as Folger, or Folger's Early, is a strain of Early Amber originated as an improved sirup variety and having all the characteristics of Amber sorghum, being probably equally valuable for forage purposes.

A head of Amber sorghum is shown in figure 1, while a portion of a field of this crop appears in figure 2.

ORANGE SORGHUM.

The Orange sorghum is of South African origin and differs from the Amber variety in having larger and heavier stalks and larger and more abundant leaves. The seed heads, also, are heavier and much more compact than those of the Amber variety, being commonly about 3 inches wide and 5 to 7 inches long, varying from an oblong outline to fan-shaped, with the top of the panicle rather loose and open. The glumes, or chaff, are deep red or black at maturity, but as the reddish-yellow seed projects from between these glumes rather more than in the Amber variety the general color in the head at maturity is not so dark, owing to the combined colors of the dark glumes and the lighter colored seeds. Just before ripening the seeds are almost white, and the variety has therefore been described as white-seeded. The Kafir name under which it was introduced and grown for several years is Neeazana.

The Orange sorghum, or Early Orange, as the standard variety is usually called, is somewhat later than the Amber sorghum, requiring usually from two to three weeks longer to reach maturity. It generally grows taller, and this, with the heavier stalks and larger leaves, usually gives it a slightly heavier yield per acre when grown for forage. Various forms of this well-known variety are offered on the market at the present time. Among them are the Kansas Orange and the Late Orange. Forms offered a few years ago were called the Improved Orange and the Perennial Orange, the latter being, however, simply the name applied to Early Orange in the extreme South, where the stubble sometimes remains alive through the winter and gives another year's growth from the same roots.

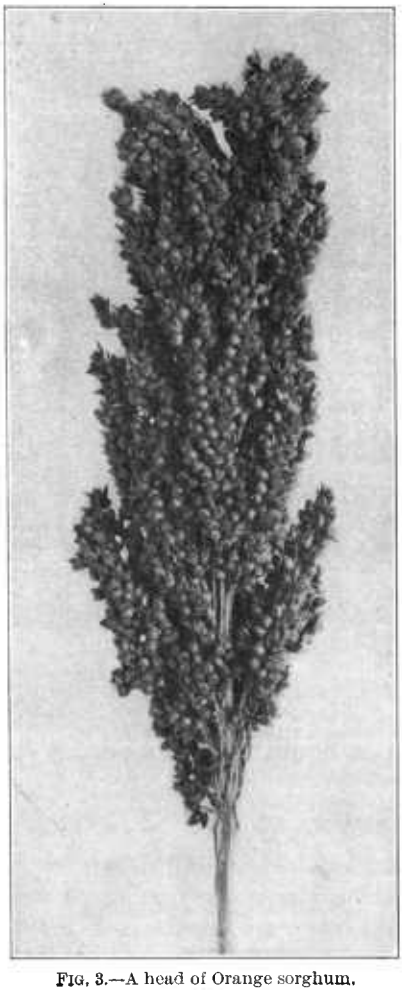

FIG. 3.—A head of Orange sorghum. (One-half natural size.)

The Colman is a variety which is said to have originated as a hybrid between Early Amber and Orange sorghum. In size, character of the seed head, and time required for maturity it is much more closely related to Orange than to Early Amber. It has been on the market for many years, originating as a sirup variety, but it is now cultivated both for sirup making and for forage.

Collier, as now sold in this country, is another variety of the Orange type. When first introduced and given this name it was a distinct variety, quite different from Orange, but the pure Collier, which was originated as a sirup-producing variety, seems to be no longer grown.

Figure 3 shows a head of the Orange variety of sorghum, while in figure 4 is illustrated a growing field of this crop.

SUMAC OR RED-TOP SORGHUM.

The variety called Sumac or Red-top sorghum may quite certainly be identified with that one of Mr. Wray's original varieties from Natal which was called Koombana. It appears never to have been cultivated in this country under that name. As early as 1865 what seems to be this variety was figured and described under the name of Liberian sorghum. A description of Liberian sorghum given in 1869 may surely be identified with the Sumac variety. Ten years later there appeared a figure and a description, under the name of Chinese Sorgho, or Sumac, which are certainly referable to this variety. It has also been called Red Liberian and Red Imphee. There is no evidence whatever to show that any saccharine sorghums were ever imported from Liberia. The name Liberian was doubtless given it to increase its commercial value at a time when new varieties were much sought after. At the present time it is known as Redhead, Red-top, or Red-top African, as well as Sumac sorghum.

FIG. 4.—A field of Orange sorghum.

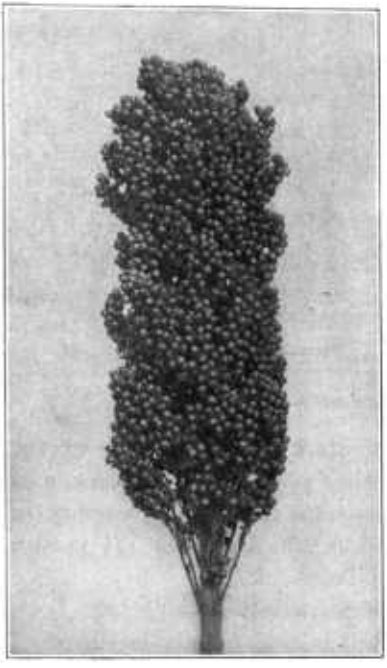

FIG. 5.—A head of Sumac sorghum. (One-third natural size.)

Very early in its history it was noted as remaining quite true to type where many of the other African varieties were exceedingly variable. This trueness to type in form, size, color, etc., is characteristic of it at the present time.

It is a stout, stocky variety with an abundance of large, broad leaves. The seed heads, or panicles, are stout, thick, cylindrical, and erect; 6 to 9 inches long; frequently blunt, and sometimes somewhat spreading at the top. The branches of the seed head are very short and full of

seed. The seed is the smallest of any of the varieties grown in this country, a brownish-red in color, and in shape obovate (or egg-shaped with the large end outermost). The glumes, or chaff, are also very small, much shorter than the seed, hairy, and varying from deep red to black in color. The red color of the head, from which so many of its varietal names have been derived, is due, of course, to the seeds, which project so far beyond the glumes that the whole panicle appears red. Sumac sorghum grows from 7 to 10 feet high, according to its environment, and is usually of very even growth throughout a field if the land is uniform in character. It is medium early in time of maturity, requiring from ninety to one hundred and twenty days.

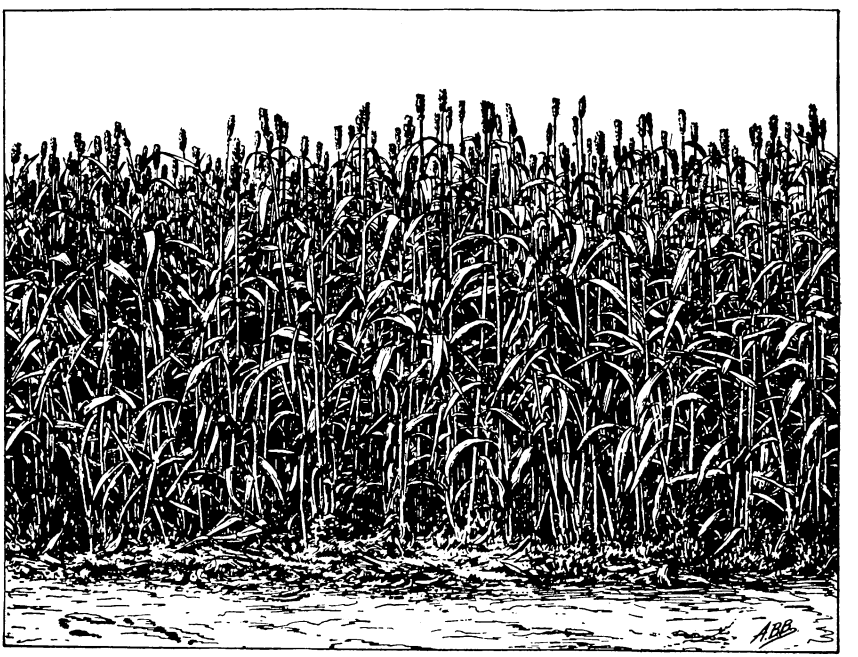

FIG. 6.—A field of Sumac sorghum.

Sumac sorghum is quite largely cultivated in certain parts of the South, especially in the Piedmont and other portions of the southern Appalachian mountain system. It is perhaps the leading variety in parts of Tennessee, north Georgia, and north Alabama. It is also quite largely grown southwestward into Texas.

There seem to be at the present time no varieties which have been derived from Sumac sorghum. Though it is sold under the different names mentioned, there is apparently but one form of this variety.

In figure 5 is shown a head of Sumac or Red-top sorghum, while a field of this crop is illustrated in figure 6.

GOOSENECK SORGHUM.

Gooseneck sorghum is very distinct from any other variety now grown in this country. It is probably a direct descendant, with little or no variation, of one of the original imported African varieties. One or two of these are known to have had their heads borne on the recurved and pendent stems, called "goosenecks," though it is not known which ones these were, owing to the very meager descriptions.

Gooseneck sorghum has been referred to in publications under that name for more than twenty-five years and was widely known among sorghum planters from about 1876 to 1890. It is said to have been a leading variety in some parts of the South, but in recent years has become almost unknown. It is still grown at Eagletown, N. C., where it has been cultivated for at least thirty years. It has also remained in cultivation at one point in Texas and in Arkansas. Very likely it has been grown sparingly in other parts of the South. The seed secured from the few seedsmen who still advertise it has proved, upon testing it, to be Amber or some other variety.

FIG. 7.—A head of Gooseneck sorghum. (One-third natural size.)

The sorghum so extensively advertised in Texas during the past two years under the name of "Texas seeded ribbon cane" proves on investigation to be only the Gooseneck sorghum under a new name.

The Gooseneck is the largest of our sorghum varieties. It grows commonly from 10 to 12 feet high, and where sown thinly, for sirup making, the stalks are from 1 to 1½ or 2 inches in diameter at the butt. At Washington, D. C., the diameter of mature stalks was from 1 to 1⅜ inches at the base, with a height of 12 feet, and this in a plat sown more thickly than would be done for sirup. In the fields observed in Texas this variety has stood up very well, showing little tendency to lodge under the influence of winds. The lower part of the stem usually becomes quite red in color.

The heads at maturity are nearly all goosenecked and almost black in color. (See fig. 7.) They range from 5 to 9 inches in length and

from 3 to 5 inches in width. In shape they vary from ovate, or rather elliptical, to triangular. The black color is due to the glumes, which completely inclose the seed. The glumes are black and shining, though sometimes grayish by reason of being quite hairy near the tip. The seeds are reddish yellow, obovate, and rather shorter than those of the Amber and Orange varieties. The flower is awned.

This variety is much later than Amber and a week to ten days later than Orange and Sumac sorghums. It can not be safely grown, therefore, north of the latitude of Washington and St. Louis. South of that line it is likely to become a favorite with sirup makers on account of its large size and large yield of juice. Its greater height and stouter stalks are not likely to commend it as a forage variety over the others now grown for that purpose.

CONDITIONS OF GROWTH.

In its needs and adaptabilities sorghum is more closely comparable with corn than with any other farm crop. It makes its best development under the same conditions which favor the best growth of corn. It thrives on the same soils and in the same climate, and as a general rule it will do well wherever corn is successfully grown. At the same time it is superior to corn in some important particulars, such as drought resistance and, usually, forage yield, though perhaps inferior in other respects.

CLIMATE.

Having originated in the Tropics, sorghum naturally reaches its best development where high temperatures prevail. Through many centuries of cultivation it has acquired, if it did not originally possess, a very high degree of variability and consequent adaptability to widely differing conditions. It is cultivated successfully in the humid Tropics and in all warm and temperate regions, both humid and semiarid. Early varieties have extended the range of its profitable growth northward in America almost to the northern boundary of the United States. In northern China and in Manchuria it is grown abundantly at the latitude of 42° to 45° north, where it is a very important crop.

SOIL.

Sorghum is best adapted to warm soils, and hence thrives best on rich, sandy loam. On heavy, poorly drained, or cold soils germination is likely to be slow and uneven, and often very poor stands result. Growth is also checked, owing to slow development of the root system. Sorghum normally develops a strong and deep root system before a vigorous growth of the young plant begins.

It has been said that land which has become too poor and thin to raise corn and small grains will still grow two or three good crops of

sorghum without additional fertilizer. If true, this is probably explained by the fact that sorghum roots quite deeply. The actual depth reached by the roots of sorghum is probably no greater than that to which corn roots penetrate, but a larger part of the root growth is found at greater depths than in the case of corn. Hence not only would its food supply be drawn most largely from the greater depths of soil, but these lower strata would be loosened and mellowed, thus permitting deeper penetration of plant food and also of the roots of subsequent crops. If additions of plant food in the shape of manure or other fertilizer are not made, the subsoil will be robbed and the mechanical betterment will be of little value except in assisting to counteract the effect of drought.

EFFECT ON THE LAND.

Sorghum is commonly reputed to be "hard on the land," and in a sense this is true. Any crop which produces enormous quantities of forage or grain removes a correspondingly large amount of plant food from the soil. Sorghum often affords three cuttings a year in the Gulf States and two cuttings through the central part of this country. It is not surprising, then, that it is hard on the land. On rich soils, however, good yields have been secured for many successive years without perceptibly lessening the soil fertility. As in the case of corn and similar plants, its draft upon the soil is not so great in proportion to the tonnage produced as is that of the common grain crops.

It is probable that the observed bad effect on land is due more to the physical condition in which the soil is left than to an actual reduction of fertility. The large quantity of coarse stubble left in the soil, especially where the crop is grown rather thinly in drills, hinders perfect preparation for the next crop. If the land is dry when plowed clumps of stubble are likely to become the centers of great clods, which are broken up only with difficulty. Sorghum also continues its growth later in the autumn than many crops, and thus continues to remove moisture from the soil until a late date. If the land is then sown to a winter crop there is not sufficient moisture remaining to give it a successful start, and the failure is then laid to the impoverishment of the soil by the preceding sorghum crop. This complaint has been more frequently made against Kafir corn than against the saccharine sorghums.

ALKALI RESISTANCE.

In California and elsewhere good yields have been secured on soils supposed to contain a high percentage of alkali, and hence sorghum has come to be regarded as a good crop to use in rotations on such land. Sorghum does excellently on the "red-land" formation of Oklahoma and northwest Texas. It has also been grown with some success

on the alkali soils of New Mexico and Arizona. Not enough is yet known, however, of the resistance of this crop to the amounts of alkali present in these soils during the growing season to justify exact statements. With its well-known drought resistance, however, there seems to be a promise of greater usefulness for this plant in the West and Southwest.

DROUGHT RESISTANCE.

Both the saccharine and the nonsaccharine varieties of sorghum endure drought better than corn, and are also less susceptible to the injurious influences of hot winds. It is believed that Kafir corn and certain other nonsaccharine forms possess greater powers of drought and heat resistance than the saccharine varieties. The statement has been not infrequently made, however, especially in Kansas and other portions of the semiarid plains region, that the saccharine sorghums have proved themselves fully as valuable in this respect as any of the nonsaccharine varieties. It is undoubtedly true that the area devoted to saccharine sorghums in the State of Kansas is increasing less rapidly than is the area devoted to Kafir corn. This may, however, be explained by the fact that Kafir corn is grown on a large scale in that State as a grain crop in place of corn, as well as for forage purposes.

This one fact of established drought resistance has done much to make sorghum the leading crop in the drier parts of the South and West, and if this resistance can be increased by proper selection and breeding of new varieties with greater adaptabilities in this line there is no doubt that sorghum will easily become an exceedingly important crop in all the arid and semiarid regions of the United States. It now has a striking superiority to corn in this respect, remaining fresh and green through periods of drought that would ruin corn. Even where its growth has been checked by severe drought it will entirely recover and give an abundant yield if favorable conditions again prevail.

METHODS OF CULTURE.

PREPARATION OF THE SOIL.

Many different methods of preparing the soil for sorghum are practiced in various parts of the country. In general, it may be said that the land should receive essentially the same treatment as if it were to be planted to corn or cotton. The time and depth of plowing will necessarily vary according to the climate, the season, and the character of the soil.

There are two essentials in preparing the land. One is a deep and thoroughly mellow seed bed and the other is the greatest possible freedom from weeds. Both are very necessary to the best results in

strong germination, vigorous growth, and heavy yield. Sorghum sends its roots deeply into the soil before it makes a very large growth of stalk and leaves. The more mellow the soil and subsoil the more rapidly can this root development take place, and the safer will the crop be from the influence of drought. Again, if the land is foul with weeds they are likely to overtake the sorghum in this period of its slow growth. Where this occurs in broadcasted sorghum it is usually necessary to plow up and replant. The danger is much greater in a wet and cold season, when the sorghum is checked much more than are the weeds.

Plowing may be done in either the autumn or the spring, but should not be done when the land is very wet or very dry. Fall-plowed land may be plowed again in the spring or worked up by means of a disk harrow. The spring crops of weeds are certain to be very vigorous when the time for sowing sorghum arrives. They may be destroyed by working the land at intervals of ten days or two weeks until it is time to sow the seed. The working may be done with a disk harrow, smoothing harrow, or cultivator, whichever is most convenient and best adapted to the particular soil. The soil, especially where the seed is to be broadcasted on the surface, should be left very smooth and level at the last working, in order to insure full and even germination and to facilitate the use of a mowing machine.

FERTILIZING.

In its fertilizer requirements sorghum probably does not differ widely from corn. It has been grown for several seasons in succession on rich land without diminished yield, and it is said that it may be grown for one or two seasons on badly worn land and give good returns, on account of its habit of deep feeding. However, the large tonnage secured from sorghum removes correspondingly large quantities of plant food, and this should be returned for future use.

A liberal application of well-rotted barnyard manure, where available, or a preceding crop of cowpeas or other leguminous plants, will do much to keep land in condition to produce crops of sorghum forage. Such methods of fertilizing are usually cheapest and best.

Commercial fertilizers may be used, as for corn, where no other method can be employed. In the cotton belt it is a common practice to use from 150 to 200 pounds of cotton-seed meal to the acre on land to be sown in sorghum. The Florida Agricultural Experiment Station recommends throwing the earth away from the hills of drilled sorghum after the first cutting and the application of fertilizer in the rows to increase the yield of the subsequent cuttings. This would be practicable only in small areas grown for soiling purposes, and only in the southernmost parts of the country.

SOWING.

When to sow.—As a general rule, sorghum seed should be sown later than corn. It should not be sown until the soil has become quite warm; otherwise there is danger of losing much of the seed. Even if the seed remains uninjured, germination takes place only slowly and unevenly and growth is very slow when the weather is cold. Weeds are likely to overtake the young sorghum, and where it can not be cultivated they make replanting necessary. Uneven germination and growth mean uneven maturing, which makes it impossible to harvest the crop to the best advantage from the standpoint either of the labor required or of the quality and quantity of the resulting forage.

In the extreme South, sowing begins late in March, but April is the month in which the great bulk of the southern crop should be planted. It will then give from two to five cuttings, usually three. If needed to secure a rapid succession of crops or to bring a crop to maturity at a certain date, later sowings may be made through May and most of June in the South. It may also be sown as a catch crop on grain stubble in June.

In the central part of the country, or the great corn belt, seeding will mostly be done by May 25, and two cuttings are sometimes secured in favorable seasons. Sowing may be continued during May, or, for a catch crop, well through June.

In the northern tier of States sorghum, where successfully grown, will be sown from May 20 to June 10 or 15, according to the soil, season, and climate.

How to sow.—Sorghum may be sown in many different ways and with a variety of implements. It may be broadcasted on the unplowed surface of the soil and plowed or disk harrowed in or broadcasted on the plowed land and harrowed in. It may be drilled in with the grain drill, all holes open, or drilled in rows of varying distances apart by closing some of the holes in the drill. It may be drilled in rows with the 1-horse single-row drills of the cotton belt or with the 2-horse corn planter of the corn belt if special small-hole drill plates are used. It is also a common practice to plant with the combined lister.

The first method mentioned—broadcasting on stubble or other fallow and plowing the seed under—is but shiftless at best and can not be recommended, though under favorable circumstances it may give fairly good results.

Broadcasting on plowed land and working the seed in with a harrow will give good results if the land is level, light, and mellow and if abundant moisture is present. On rough land some of the seed will be buried deeply and some left on the surface, resulting in very slow and uneven germination. On heavy or packed soils the seed is likely to be covered very shallow and the crop, therefore, will be more easily injured by drought.

The use of the press drill is preferable to broadcasting on the surface, especially in the drier parts of the country, such as the plains region and the Southwest. By its use the seed may be put in at a uniform depth, usually from 1 to 2 inches, but often deeper if necessary to reach moisture in the soil. This insures quick and even germination. It also permits the use of a harrow on the young plants to destroy weeds, break the crust, and conserve moisture.

Where it is desired to sow in rows far enough apart to permit cultivation, the grain drill may be easily adapted for use by closing some of the holes. The rows may thus be made from 21 or 24 inches apart up to 35 or 40 inches or more. With the corn planter the drills will usually be 42 inches apart unless the rows are straddled.

Whether sorghum shall be sown broadcast, or in close drills, or in wide rows and cultivated, depends on several factors, such as the purpose for which grown, the machinery available for sowing and harvesting, and the necessity for conserving moisture.

In favorable seasons the heaviest yields and the finest quality of forage are usually secured from broadcasting or drilling in close rows. The stalks are finer and will be more readily eaten. The crop of hay thus sown may be cut with a mower and cured in swath and cock or cut with a self-binder with an open-end elevator and cured in the shock like small grain. When grown thus, it may also be cut with scythe or mower for feeding green.

Where grown for silage, it will of course be sown in wide rows, and may then be cut with a corn harvester. When sown in the same way for fodder, it can be most easily and economically harvested with the same machine. For green feeding to hogs or cattle it is more easily handled from a wide row than where sown as a hay crop. On poor land better results will be obtained by sowing in rows and cultivating, and in dry regions moisture can be more fully conserved by this method of treatment. Large size in the stalks may be avoided by sowing thick in the row. This method of planting permits the cultivation necessary to destroy weeds.

The use of the lister in planting sorghum is quite general in parts of Kansas, Oklahoma, and adjacent territory. This deep planting protects the young plants from drying winds and enables the roots to reach moisture more readily and thus avoid the effects of drought. In wet seasons listing is unfavorable to the growth of the young sorghum, and better results are obtained from surface planting. The lister furrows are in such seasons too wet and cold, and many young plants are buried by the soil washed down into the furrows by the running water. In general, however, the use of the lister is a valuable practice in the semiarid region.

Sorghum is also grown in combination with other crops, such as corn, millet, cowpeas, soy beans, etc. Notes on the use of millet will

be found in the discussion of the quantity of seed to sow and the use of sorghum for hay. Further information on the methods of handling leguminous crops with sorghum is given in the paragraphs treating of the quantity of seed to sow and the use of sorghum for silage. The use of cowpeas or some other legume is to be highly recommended. The feeding value of the combined crop is greater than that of sorghum alone, since the two make a more nearly balanced ration than either gives by itself. The legumes also assist in keeping up soil fertility by their power of obtaining atmospheric nitrogen and storing it in their vines and roots through the agency of the bacteria present in the nodules, or tubercles, on their roots.

Quantity to sow.—The quantity of seed required to the acre of land will vary according to the purpose for which grown, the time and method of sowing, and the character of the soil. It is commonly recommended to broadcast or sow with a press drill at the rate of 1 to 1½ bushels to the acre. Occasionally as large a quantity as 2 or 2½ bushels has been advised. For sowing in drills 3 or 3½ feet apart from 8 to 20 pounds is usually recommended.

The Iowa Agricultural Experiment Station found that practically the same yield was secured in all three cases where 40, 80, and 100 pounds of seed were drilled, but that the stalks from the thicker sowing were finer and somewhat more watery but less saccharine. The Wisconsin Agricultural Experiment Station found that 25 pounds to the acre sown with all the drill spouts open yielded about one-fifth more than where every alternate spout was closed. Fifty pounds to the acre, however, sown with all spouts open, gave about one-seventh more than did 25 pounds sown in the same way.

The customary weight to the bushel given sorghum seed in the seed trade is 50 to 60 pounds. The legal weight varies in different States from 30 to 56 pounds. In Kansas, the greatest sorghum-growing State, the legal weight per bushel for both sorghum and Kafir corn is 56 pounds, and that is probably the ordinary weight of fairly well-cleaned seed. Both will frequently weigh over 60 pounds to the bushel where entirely free from hulls.

The writer found that 28,000 seeds of Sumac or Red-top sorghum, 28,800 seeds of Orange sorghum, and 25,000 seeds of Amber sorghum were required to weigh 1 pound. Clean or hull-less seeds were used in all three cases. Prof. W. A. Henry found that 27,600 seeds of Early Amber were required, while Prof. Peter Collier found only 19,000 in 1 pound from Virginia and 31,800 in a pound from Minnesota. Nothing is said as to whether the Virginia lot was free from hulls. It seems probable, therefore, that clean seed varies from 25,000 to 30,000 to the pound.

If sorghum is drilled in rows 3½ feet apart, with the seeds 1 inch apart in the row, it would require 156,400 seeds, or somewhere near

6 pounds, if all the seeds grew. When the seed is sown with a grain drill, spouts 7 inches apart and all open, it will require 938,400 seeds to sow one every inch in the row, or about 37½ pounds to the acre, allowing 25,000 seeds to the pound.

From these figures it may be seen that from 10 to 20 pounds is quite sufficient for sowing in rows as far apart as corn rows, even allowing for poor germination. Where sown for hay with a grain drill, all spouts open, 1 bushel of seed should be amply sufficient, allowing for all unfavorable conditions. Less seed should be used in regions of deficient rainfall than where moisture is more abundant. In western Kansas the usual custom is to sow one-half bushel to the acre. For broadcasting on the surface it is advisable to use rather more than a bushel to allow for much that will not come up and to enable the crop to smother weeds.

CULTIVATION.

Sorghum sown broadcast and harrowed in can be harrowed until 4 to 6 inches high without injuring the young plants. Where sown with a press drill the field may be run over with a smoothing harrow when the sorghum is only an inch or two high, and this cultivation may be continued until the young plants are 6 inches tall. This permits the destruction of any weeds that may appear and the breaking up of the crust if one has formed. Sorghum sown in wide rows should be cultivated in the same manner as corn.

In dry regions or in time of drought in any place, cultivation should be frequent and shallow to conserve moisture.

After the first cutting is made, the ground should be again stirred, and more deeply, with a disk harrow or cultivator. In most of the South, where sprouting takes place quickly from the cut stubble, it is not injurious but really beneficial to run the disk harrow not only between the rows but over the stubble rows themselves. Farther north or in drier regions it may be necessary to restrict the cultivation to the ground between the rows. Disking over the stubble rows might be injurious where the soil is too dry or too cool to induce quick sprouting of the second growth. Where irrigation is practiced the water may be turned on to start the second crop. The same methods should be employed with each succeeding cutting.

HARVESTING AND CURING.

Sorghum is commonly grown for soiling, pasture, hay, fodder, and silage. The time and method of harvesting will differ somewhat for these different uses. In general it should be cut when it is well headed out and the seed is hardening.

Soiling, or green feeding.—Sorghum may be used as a green feed from the time it is 2 feet high until nearly ripe. It is not as profitable

to commence cutting before the heads appear on account of the small yield and its inferior feeding value. It is sometimes necessary to do so, however, when other feed fails, or when allowing it to stand longer would prevent an additional cutting. Sorghum will sprout again from the stubble more quickly if cut quite young than if allowed to form heads and become more nearly mature. Under similar conditions a crop from stubble comes to maturity in less time than a crop from seed, because the root system is already established.

Hay.—Where grown for hay, sorghum may be allowed to stand until after the first light frosts if not sufficiently mature. In case a heavy frost strikes it while still standing, it should be cut at once and will be found only scarcely injured, if at all. If left standing three or four days after such a heavy frost, it will be found unpalatable to stock.

Broadcasted or close-drilled sorghum may be cut either with a mower or with a grain binder. When cut and bound with a binder, the bundles are set up in small shocks like small grain and allowed to cure in the shock. The hay may then be put in a mow or stack, or fed directly from the shock. The ordinary grain binder may be adapted for sorghum cutting by an extension reel and open-end elevators. The binder is used more commonly in Kansas and adjacent territory than anywhere else. It will probably be more successful in that dry region than in moister climates, since the danger of spoiling in the bundles is considerably less. The bundles should not be too tightly bound.

When cut with a mower there are two quite different methods of handling the hay. The older and probably still the more common method is to cure the hay in the swath, then in windrows, and finally in cocks, as ordinary hay is handled. This method has the advantage of getting rid of the moisture as fast as possible before the hay is handled much. The weight is thus largely decreased and the labor and expense of handling the hay are also decreased. On the other hand, the curing hay is exposed to sunshine and dew, often to rain and to frost, all of which affect its quality. It must be handled more times before the curing is finished, which in part offsets the gain of handling a smaller weight.

A more recent method, and one which is growing in favor, is to allow the cut hay simply to wilt down in the swath, and then to rake it at once into large cocks, the size of which will depend somewhat on the size of the stems of the sorghum. Where it is fine and slender, the stems not larger than the little finger, it is best to make the cock not much larger than the ordinary haycock. If the stems average nearer the size of the thumb, the cock may be made two or three times as large. The cocks should be dressed down with a fork to shed water

well. They are also sometimes capped with straw or hay for the same purpose. No effort is made to cure the hay before putting it in the cock, the curing being all done in the cocks. If the stems are not too large there is little danger of molding or spoiling in any way unless under very unfavorable conditions.

It is evident that between the two extreme methods of entirely curing the hay before putting it up and of putting it into the cock while very green there are many intermediate variations in practice. The individual farmer will adapt such of these methods to his crops and climatic conditions as his own experience and circumstances warrant.

Fodder.—The term fodder is used to distinguish sorghum sown thinly, and consequently having large stalks, from the hay crop just discussed. Sorghum fodder is very largely cut with a corn binder and shocked. Small areas are cut by hand with a corn knife or occasionally with a mower, if the stalks are not too large. As in the case of hay, there is a conflict of opinion as to the best method of curing fodder. When the corn binder handles the crop the bundles are made as small as possible for ease of handling and curing. These bundles are then allowed to cure for a few days on the ground or set up in small shocks to cure for a time, and finally a number of these smaller ones are put together to form one large shock. These large shocks may be hauled to the mow or stacked near the feed yard, or they may be left in the field until winter and hauled only as needed. The large shocks should be well tied at the top or capped to prevent the entrance of too much water at that point.

Some growers put the bundles into large shocks within thirty-six or forty-eight hours after cutting and before they have cured to any appreciable extent. This, they claim, gives as good results in cured product as the same method of handling the unbound hay. The greatest objection to it is probably the great weight of the green fodder. It shrinks at least three-fifths or two-thirds in curing, and the handling of this enormous amount of water is an important item in the labor of making sorghum fodder.

Sorghum fodder is sometimes put under a shelter to cure. A lean-to, or merely a roof supported on poles, may be used for this purpose. Sometimes the bundles are placed in long lines against a convenient fence, saving the trouble of making the small and temporary shocks. This method is especially valuable along the Gulf coast, where the rainfall is heavy.

Another method sometimes used where the quantity to be cured is not very large is to make a tripod of three poles about 20 feet long, in the same manner as for drawing up the carcass of a beef animal for dressing. The ends of the poles are set in the ground and the tops lashed together. Strips of rough board are then nailed horizontally

from one pole to the other, thus inclosing a triangular air space about 8 feet across at the bottom. A platform of rails, raised about 2 feet from the ground, is then built around the triangle and the sorghum hay or fodder shocked on this. Free circulation of air is thus permitted and the forage is cured without spoiling. It is said to be possible to stack forage entirely green by this means without danger of spoiling.

There is, of course, much greater difficulty in curing fodder in the humid parts of the country or in wet seasons than in a semiarid region or in a dry season. If the fodder crop can be so timed as to be ready to cut in August or early September it will cure much more rapidly than if harvested a month or so later. In August the drying effect of the sun is much greater and there is less likelihood of a long period of wet weather, such as commonly occurs later in the autumn. In parts of the semiarid region the great heat of August may make it desirable to have the harvest come somewhat later.

Where sorghum fodder or hay is put into a stack or mow without being well cured, any injurious effects of such storage may to some extent be prevented by using alternate layers of dry straw with the sorghum. The straw absorbs the moisture from the sorghum and thus helps to prevent too great heating and subsequent molding or souring.

Silage.—Sorghum is cut for the silo from the time the seed is in the milk stage until it is well ripened. There is often complaint about the souring of sorghum silage, and for that reason considerable prejudice exists against its use in the silo. This difficulty arises partly from cutting it in a too immature condition. The objection can be partly overcome by cutting it only after the seeds have begun to harden. The proportion of fiber rapidly increases at this time, and the crop should not be allowed to become fully mature before cutting. This increase of fiber would be less objectionable in silage than in other forms of sorghum forage, because silage is finely cut and is fed in a moist condition.

Seed.—Very little sorghum is grown for seed production alone. The bulk of the seed crop harvested is derived from sorghum grown for sirup or fodder. Where grown primarily for the seed, the stalk is generally saved for fodder, and the time and manner of handling are influenced by the double purpose for which the crop is grown.

Where the seed heads are saved from sorghum cut for sirup making, they must of course be removed before they are in any way cured, and great care is necessary to prevent their heating if placed in piles. The heads may be cut from the stalks either while still in the field or after they are hauled to the mill.

When the sorghum is grown for fodder, the crop is usually cut with the binder and shocked. Whether the bundles lie on the ground for a time to cure or are put at once into shocks, either small or large, the

heads should be removed before making the final large shocks. The heads are cut off with an ax, corn knife, or saw. In Kansas it has been recommended to rick the bundles, butts out, for a time, and then in handling them place them on a low wagon, heads out, and cut off the heads with a hay knife or cross-cut saw. In the Panhandle district of Texas the most improved separators have a circular saw attachment which removes the heads, allowing them to fall upon the feeding table, while the bundles of stover are carried away intact.

When grown primarily for seed, the heads may be removed from the standing crop with the header, and stock may be allowed to run in the stalks. The harvesting may also be done in any of the ways just described.

The heads may be cured in piles or layers, taking care not to let them heat sufficiently to injure the seed. Thrashing is done in ordinary grain separators. Sometimes a part of the concaves are removed to prevent cracking the seeds.

YIELD.

The yield of sorghum grown for hay or fodder varies widely; yields of green forage ranging from 5 to 40 tons are reported, and it is difficult to determine an average. From 8 to 20 tons is probably near it. The range of yield of cured hay or fodder is reported as from 2 to 12, or occasionally 15 tons to the acre. The average yield in the Central States seems to be from 3 to 8 tons. The recorded shrinkage in curing is about two-thirds or three-fifths, which accords fairly well with the figures for yield of green and cured forage. Some investigators place it as low as one-third, others as high as five-sixths. Yield depends on latitude and the number of cuttings obtained, as well as on the season, soil, method of sowing, and similar factors. The yield from a first cutting allowed to become nearly mature will be larger than from the succeeding cutting from the same roots. Ordinarily, however, the first cutting is made before or at the time of heading and will therefore be light, while the second cutting will be a heavy one, unless it also is cut early to prepare for a third, and so on.

It is generally agreed that the yield from broadcast or close-drilled seeding is usually somewhat heavier than that from wide drills. This also will depend on the season.

It is the opinion of the majority of those who grow both corn and sorghum that sorghum will ordinarily outyield corn for forage. Except in the heart of the corn belt it will exceed the tonnage of corn to the acre by about one-third. It can be grown at about the same cost for each ton and can be fed with much less waste.

Few, if any, reliable statistics are at hand regarding the yield of seed to the acre, or the total production for this country. The yield

ranges from 10 to as high as 60 bushels to the acre, with the average probably about 25 to 30 bushels.

Most of the sorghum grown for hay and fodder, as well as for sirup, produces abundant seed. If harvest is delayed until the seed is nearly ripe, as is commonly done in the case of the fodder and sirup crop, a seed crop also may be obtained. It is from such combination crops that most of our seed is secured. Sorghum grown for sirup is sown more thinly than for any other purpose, which gives the best opportunity for the development of large, heavy seed heads. The best quality of seed is probably obtained from this source.

USES AND VALUE.

SOILING, OR GREEN FEEDING.

Stockmen are unanimous in placing a high value upon sorghum for soiling purposes. It is not only an excellent forage for growing animals and those which are being prepared for market, but is one of the best feeds that can be used during the summer and early autumn for dairy cattle, on account of the large flow of excellent milk which it induces.

In many dairying and stock-raising communities one of the most critical periods of the year is that of the dry season, during July, August, and September. At this time the pasturage is often insufficient for the stock and great difficulty is experienced in growing enough early fodder to keep the animals in a thrifty condition. Sorghum, on account of its drought-enduring qualities and ready adaptability to varying conditions of soil and climate, as well as because of its feeding value, is one of the best crops that can be grown for this purpose. The crop from a single sowing can not be fed for much longer than fifteen or twenty days unless the cutting commences when the sorghum is very young. By a judicious selection of early and late varieties or by planting several fields at different times a succession of crops can be had, each of which will be in its prime when wanted. Whatever surplus there may be can be cured for winter feed.

It is difficult to get accurate data on the actual feeding value of sorghum in the fresh state, as compared with that of various other soiling crops. The ease and certainty with which it may be grown and its great productiveness are strong points in its favor, even though it may not equal in value some other crops, such as legumes. An acre of sorghum yielding 15 tons of green forage would feed 50 head of stock for 10 days or 25 head for 20 days, allowing each animal 60 pounds a day.

Sorghum may be fed green to all kinds of stock, even to poultry, with very profitable results. A full feed should not be given at first,

particularly if the animals are hungry. It is a good practice to give first a light feed of grain or other food and then a small quantity of the sorghum. The latter may be increased day by day until a full feed is reached. Fresh sorghum is a very succulent forage and, like clover, is liable to cause bloating when fed in too large quantities at first. With ordinary precautions no trouble from this source need be feared.

PASTURE.

Sorghum is a satisfactory summer pasture for all classes of stock, but especially for sheep and hogs. Cattle should be accustomed gradually to sorghum pasture, as they are likely to overeat, especially if coming from scant pasturage.

For pasture, sorghum should be sown or drilled thickly. If several fields are sown one after another at short intervals, a succession of pasturage will be afforded. By the time the last has been grazed the first should be ready for a second grazing.

The practice of pasturing sorghum has not yet become general. There can be no doubt of the value of sorghum to supplement failing pastures. Whether it should be pastured or used for soiling will depend largely on the kind of stock and on local conditions. The points in favor of pasturing are the saving of labor and the accumulation of manure in the field where needed. Also sorghum may be pastured when of smaller growth than could be profitably cut for soiling, and young sorghum is a more nearly balanced ration than when full grown.

On the other hand, pasturing usually requires the expense of some fencing, permanent or temporary. There is also the danger of losing stock from sorghum poisoning, as discussed on page 32.

Sorghum pasture is said to enable hogs to maintain a steady and profitable growth through the summer months, leaving them in condition for rapid fattening with a light grain ration in winter. There can be no doubt of its value for cows, sheep, and other stock.

The carrying capacity of an acre of sorghum pasture depends on the height of the plants as well as on other factors. It has been determined that an acre will afford from about ninety days' grazing when 2½ feet high to about one hundred and twenty days when 4½ feet high. It is understood that the crop could not actually be grazed for so long a period, but would sustain its equivalent, say six head for fifteen or twenty days, respectively. If properly handled and under favorable conditions the grazed field should continue its growth and be ready for a second grazing in a month.

The evidence is in favor of grazing sorghum before it heads, as there is then no waste and the crop is more nearly a balanced ration. Growth will also be more promptly renewed at that stage.

Mixtures of sorghum with grain, as barley or oats, have been found to give heavier yields than sorghum alone. The addition of some legume, such as vetch, crimson clover, field pea, or cowpea, may sometimes be profitably made.

Poisoning.—The fact has long been known that growing sorghum is under some circumstances a virulent poison to stock. Many theories have been advanced to account for this fact. Only within the last three years has the formation of prussic acid in the leaves of the plant been proved to be the cause of the fatalities observed. Credit for this knowledge should be divided between the Nebraska Agricultural Experiment Station and some English investigators, who published their results at almost the same time.

It is known that prussic acid is not present as a free substance in the sorghum, but is formed under certain abnormal conditions. These conditions are not yet fully known. Immature sorghum of checked or stunted growth, due to dry, clear, hot weather, seems to be most favorable to the formation of the deadly acid. Young plants seem to be more poisonous than mature ones, other conditions being equal. Second-growth sorghum is probably not more dangerous in itself than the first crop, except that it is more likely to encounter the particular conditions of weather mentioned above. Cured sorghum is generally considered not to be dangerous.

No certain remedies can be given. Indeed death often results too quickly to permit any remedial treatment. It is known that prussic acid unites with certain carbohydrates (starches, fats, etc.) to form less dangerous compounds. Glucose or corn sirup is one which is commonly available for prompt use. Large quantities of milk may be used. In all cases allow the animal plenty of fresh air.

Cattle on a grain ration can apparently eat more of the poisonous sorghum than animals not so fed, because of the effect of the starch contained in the grain. Cattle should not be pastured on stunted, drought-stricken, or frost-bitten sorghum, or at least not till a single animal has been allowed to test it thoroughly.

HAY.

No definite line can be drawn between hay and fodder. The acreage of sorghum sown thickly enough to be classed and handled as hay is probably considerably smaller than that grown for fodder. Sorghum makes a very palatable and nutritious hay that is relished by all kinds of stock, including hogs, and can be successfully used in the feeding ration. It is scarcely fair to compare sorghum hay with alfalfa or clover hays, which, like all leguminous hays, are rich in protein, and therefore more nutritious feeds. Where a protein feed is added sorghum hay has been found well adapted to fattening sheep and lambs, and could probably be used for other stock in the same manner.

Sorghum hay and fodder are said to be frequently sour and unfit for feeding after midwinter in southern Nebraska and Kansas. This trouble is probably due to the alternate freezing and thawing of the stalks. Farther north, where winter thaws are infrequent, and farther south, where freezing is less severe, this souring is not so common. Kafir corn, which is less juicy and less saccharine, keeps better and is fed after the sorghum is spoiled.

FODDER.

Sorghum fodder is handled and fed in much the same manner as corn fodder. .It may be fed in a rack or on the ground; whole or cut with a feed cutter; alone or mixed with grain, chop, bran, or other feeding stuffs. This last method is especially adapted for use in dairy farming. On account of its saccharine juice, sorghum fodder is usually eaten more readily and completely than either corn or Kafir fodder. Very large quantities are now fed annually. It is excellent winter roughage for all classes of stock. Work stock have been kept on it during the summer season with good results. Hogs may be fattened with a reduced grain ration when fed on sorghum fodder, and all uneaten portions are worked into the bedding and manure. Owing to the larger size of the stalks there is more trouble from the souring of fodder than of hay. This is most noticeable where it has not been well cured.

SILAGE.

There is still some difference of opinion as to the value of sorghum for silage. The silage ferments more than corn silage, owing to the saccharine juice, and hence does not always keep as well. There is no question as to its value when well preserved. Sorghum is a better yielder than corn on poor soils, and a surer crop in semiarid regions. In the great corn belt its use is slowly increasing, while along the Gulf coast, where the heavy rainfall makes it difficult to cure fodders, sorghum is a profitable silage crop and can be most successfully handled in this way.

In feeding value, sorghum silage appears to be slightly inferior to corn silage, the protein content being rather lower and the fiber content rather higher. However, the amount of water to the ton is also lower, so that the total amount of nutrients in each ton is larger than in corn silage.

The feeding value of both corn and sorghum silage can be increased by adding some leguminous crop. The two crops may be sown separately and mixed while being cut into the silo, or grown and harvested together. The cowpea is probably the best crop for this purpose. Such varieties as the Black, Blackeye, Clay, Red Ripper, and Whippoorwill

are commonly used. Soy beans may also be used. Numerous cases have been reported, however, where soy beans alone or a large proportion of soy beans in corn or sorghum silage have produced a silage which imparted bad odors to milk and other dairy products. Experiments show that no bad effects result from using a small proportion of soy beans, one part of soy beans to five or six parts of the other silage crop being regarded as safe.

Sorghum silage has been largely used as a winter ration and as a supplementary summer ration for dairy herds, with highly satisfactory and profitable results. This is especially true in parts of the South, where from a hundred to over a thousand tons are put up annually at several points. In the North it is growing in favor, even in competition with an abundant and profitable corn crop.

For the drier parts of the Southwest a stack or rick silo has been recommended. The sorghum is said to be stacked in large ricks, butts out, as soon as cut, weighted down, and allowed to ferment. This practice was never common and does not seem to be followed to any extent at the present time. It has recently been advised for the Guinea corn grown in the island of Jamaica.

CATCH CROP.

Sorghum is receiving favorable notice as a crop for late planting in the Middle and Northern States. There is frequent need for a crop which can be sown in midsummer after an early grain or hay crop, or after other crops have been destroyed by hail, flood, or insects. Early maturing varieties like Amber and Folger are well adapted for this purpose if sufficient moisture is present to insure germination. Deep planting may be necessary to reach such moisture. Sorghum grows well in summer weather.

SEED AS A GRAIN RATION.

About forty years ago, when sorghum was considered of great importance as a sugar-producing plant, there was much prejudice against sorghum seed, due to the belief that it was poisonous. Gradually that prejudice was overcome, and what was largely a waste product was utilized in feeding different kinds of stock. Later the feeding of hogs on a large scale became an industry at some of the large sugar factories. In 1883 a New Jersey factory had fully 300 hogs fattening on this seed, which was boiled before feeding, to insure complete digestion and prevent waste.

In late years, though the sorghum-sugar industry has disappeared and the sirup industry is not very large, the question of feeding sorghum seed is still of some importance. As previously stated, there are parts of the plains region and other sections in the South and West

where sorghum or some of the nonsaccharine sorghums are much more certain crops than corn in average years. To fatten hogs or cattle, grain is necessary, and the seed of some of these sorghums is the local and most accessible supply. This is more especially true of Kafir corn and milo than of sorghum, since they are better grain crops.

In chemical composition sorghum seed is very similar to shelled corn. The seed, when entirely free from hulls, contains practically the same amounts of water and of ash. In protein and carbohydrates (nitrogen-free extract) the advantage is slightly with the sorghum seed, as it contains rather more of these valuable food elements than does corn. In fat, however, the sorghum seed is distinctly lower. The nutritive ratio, or proportion of protein to carbohydrates and fat, of the sorghum seed free from hulls is 1:7.16, while that of the shelled corn is 1:7.85. The small difference is really in favor of the sorghum seed. The hulls, or glumes, which inclose the seed are coarse and hard in character, and when they are present on the seeds the analysis will always show a decided increase in ash and fiber and a corresponding decrease in protein and carbohydrates.

It must be understood, however, that the chemical analysis is only an imperfect guide to the feeding value of any substance. Palatability and digestibility, as well as physical characters, must be taken into account.

Many stockmen who have had experience in feeding the seed say that it is worth about 90 per cent as much as corn. There are others, however, who give it a somewhat lower value. It is seldom that any large quantity of seed is saved when the sorghum is grown for forage. It is usually fed on the stalk, or is cut up with it and fed as silage. When sorghum is grown for sugar or molasses, the heads are often stored and fed whole, or thrashed and the seed fed or kept for planting.

Though the thrashed seed is often fed whole, either dry or soaked, it can be used to best advantage when crushed or coarsely ground. Mixed with equal quantities of oats, peas, or soy beans, it makes an excellent food, and for most purposes is a very good substitute for corn. Sorghum seed is highly recommended as a poultry food, especially for laying hens, and has been largely used for that purpose.

CHEMICAL COMPOSITION.

In estimating its value from the chemical composition sorghum is properly compared with corn, which is the standard for coarse forage. Sorghum hay and fodder contain only about two-thirds as much protein (muscle builders) as corn fodder, but about twice as much fat and also slightly more carbohydrates (fat formers). In general the same is true of the silage made from the two plants. Young sorghum contains a larger proportion of protein than the later stages, but the pro-

portion of fiber is also higher, both facts being due to the smaller quantity of carbohydrates in the young plants. The carbohydrates are largely formed as the plants become mature and are especially abundant in the seeds.

The leaves are higher in protein, carbohydrates, and fat than the stalk and form an excellent fodder. While it is not economical to save only the leaves for forage, it is desirable to cultivate varieties having large and abundant foliage. The bagasse, or waste cane after the juice is extracted, is low in protein and fat and high in crude fiber, and therefore not a good feedstuff by itself. It has been stored as silage and fed in combination with grain or other concentrates with good results.

DIGESTIBILITY.

Digestion experiments with sorghum have not been numerous, but on the whole sorghum compares favorably in this respect with corn. The highest percentages of digestibility are secured when sorghum is cut at blooming time or soon after. It may be estimated that fresh sorghum cut from blooming until the dough stage will contain for each ton of forage about 226 pounds of digestible carbohydrates, 24 pounds of digestible fat, 14 pounds of digestible protein, 87 pounds of digestible fiber, and 1,453 pounds of water. This compares favorably with the estimates for corn and shows that, though sorghum may be somewhat lower than corn in muscle-making elements, it is higher in fat formers, and hence is an excellent feed in preparing animals for the market.

SUMMARY.

Though of tropical origin, sorghum is now grown throughout most temperate regions for both fodder and grain.

In 1899 about 1⅓ million acres of saccharine sorghum were grown in the United States, or about one-seventieth of the area devoted to corn.

Saccharine sorghum seed is sold under many varietal names, but there are only four leading varieties in extensive cultivation, viz, Amber, Orange, Sumac (or Red-top), and Gooseneck. Nearly all the others are forms of Amber and Orange.

In its general requirements sorghum is very similar to corn. It is a strong feeder and therefore will do better than corn on thin soils.

The popular idea that sorghum is "hard on the land" is probably due as much to the poor mechanical condition in which the soil is left as to the removal of plant food by the crop.

Sorghum is more resistant to drought than corn and is regarded as a better crop for alkali soils.

Sorghum should be sown in a well-prepared seed bed when the ground is thoroughly warm. The time and method of sowing and the

quantity per acre will vary with the purpose for which sown. Use plenty of seed.

Keep the weeds down by shallow cultivation while the plants are small. Conserve moisture where necessary by prompt shallow cultivation after each rain. When one cutting is made, stir the ground to promote new growth.

Sorghum is grown for pasture, soiling (green feeding), hay, fodder, silage, and seed. Methods of harvesting, curing, and storing vary with the use made of the crop.

Sorghum is especially valuable as a pasture for sheep and hogs. Cattle should be gradually accustomed to it as pasture. It makes an excellent summer and autumn feed for dairy stock.

Under certain conditions, especially when checked in its growth by drought, etc., growing sorghum becomes poisonous through the formation of prussic acid in the leaves. Great care should be exercised in letting stock have access to it at such times.

Sorghum is best cut for hay or green feeding from the time of heading until the seeds are in the dough stage.

As a forage, sorghum contains an excess of carbohydrates, or fat formers, and is best fed in connection with materials containing protein, or the muscle-making elements. The same fact is true of the seed.

FARMERS' BULLETINS.

The following is a list of the Farmers' Bulletins available for distribution, showing the number and title of each. Copies will be sent to any address on application to any Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C.

No. 22. The Feeding of Farm Animals. No. 24. Hog Cholera and Swine Plague. No. 25. Peanuts: Culture and Uses. No. 27. Flax for Seed and Fiber. No. 28. Weeds: And How to Kill Them. No. 29. Souring and Other Changes in Milk. No. 30. Grape Diseases on the Pacific Coast. No. 32. Silos and Silage. No. 33. Peach Growing for Market. No. 34. Meats: Composition and Cooking. No. 35. Potato Culture. No. 36. Cotton Seed and Its Products. No. 37. Kafir Corn: Culture and Uses. No. 39. Onion Culture. No. 41. Fowls: Care and Feeding. No. 43. Sewage Disposal on the Farm. No. 44. Commercial Fertilizers. No. 46. Irrigation in Humid Climates. No. 47. Insects Affecting the Cotton Plant. No. 48. The Manuring of Cotton. No. 49. Sheep Feeding. No. 51. Standard Varieties of Chickens. No. 52. The Sugar Beet. No. 54. Some Common Birds. No. 55. The Dairy Herd. No. 56. Experiment Station Work—I. No. 58. The Soy Bean as a Forage Crop. No. 59. Bee Keeping. No. 60. Methods of Curing Tobacco. No. 61. 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